# Corn Disease Investigations

BY EUGENE D. FUNK

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Illinois Farmers' Institute

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## CORN DISEASE INVESTIGATIONS

*(By Eugene D. Funk.)*

This subject dates back to 1892, when I first began my experiments with the investigation for improvement of better corn and farm seeds. I had just returned from a study of agricultural conditions in European countries where I found in many cases one acre of ground producing an income equivalent to three acres of our land here in this comparatively new and fertile country, and the lesson that I brought home with me was far-reaching and helped to shape my future life and study of American agriculture.

In Roosevelt's stories of the "Winning of the West" he tells of an old Indian Chief whose name was "Corn Stalk." His hunting ground was in Kentucky, along the Ohio river, and I often wonder under what unusual conditions this brave warrior received the name of "Corn Stalk." To us, throughout the middle west how common is the name "Corn Stalk" and yet, to be frank, how little we know about this most wonderful of all grain producing plants. Discovered by Columbus with the Indians, the American farmer has continued to grow corn for almost seven hundred years. Poems and eulogies have been written of corn and yet the youngest person in this audience can remember when the first real scientific study of the corn plant began. Recent investigation leads us to where we are becoming more or less aroused to the fact that our corn fields are not producing the yields that they should and that the plant, upon which we depend so much for a livelihood, is being attacked, not only with one disease, but with many diseases.

It is conservatively estimated that the corn crop of the United States is being reduced twenty per cent. A few years ago we attributed a short crop of corn to the climatic or soil conditions, or poor seed; now we have every reason to know that much of the loss is due to root rot and other diseases.

Let me say here, with much emphasis,—although I do not wish to be classed as an alarmist, if the infection keeps spreading at the present rate these diseases of root, ear and stalk, will cut the yield forty or fifty per cent under conditions that are favorable for their development. In five years from now, unless we get busy and fight this enemy, we can look for yields fifty per cent of what they should be.

It was in 1913 that our attention was first brought to the realization that our corn breeding work was being seriously handicapped by some unknown disease, but our records show to us clearly that we had more or less of the trouble as far back as 1900.

### Some Interesting History.

The first real study of corn breeding was begun about 1890, by the Illinois Corn Breeders Association, composed of a few men, who, as individuals, had been for a number of years selecting corn in various ways and saving what they considered the best seed to plant their fields each succeeding year. These men lived on their farms,

scattered over various sections of the state, but among them, of course, there was a leader, although it must be said he was not a corn breeder. He was known, and proud to be known, as the "Corn Crank." His name was E. S. Fursman and he lived at El Paso, Illinois. He dreamed about corn and he talked corn, and I have seen him talking to all the men in a smoking car all the way to Chicago—over one hundred miles—about corn. Many of them did not know what an ear of corn looked like, but talked on. Another man who was the owner and editor of an agricultural paper—Orange Judd,—together with Mr. Fursman, conceived the idea of holding a corn show at Peoria, Illinois. Through the efforts of these two men, the men who afterwards formed the Illinois Corn Breeders Association became acquainted with each other and resulted in many warm and close friendships. These men met periodically and discussed the problems of corn improvement. Each of these members had his own ideas regarding what constituted the best type and his own theories as to how to improve the yield. None had any practical experience in corn breeding, with the exception of James Reid, of Delavan, Illinois, who had worked in Reid's Yellow Dent for fifty years in a way that is now considered crude.

At first our association had eighteen members and about eighteen different ideas as to the right type to grow, but after considerable discussion we compromised and decided that the rought type was the ideal one to produce in the corn belt. We formulated a score card, working out mathematically the ideal ear,—cylindrical, carrying this type from tip to butt, and well covered at both ends with deep, medium rough, wedge shape kernels. We undertook to grow strains from all varieties we had that would measure up closely to the ideal we had conceived.

At that time there were seven varieties recognized as a standard for the middle west: Reid's Yellow Dent, Leaming, Boone County White, Silver Mine, Riley's Favorite, Golden Eagle and Champion White Pearl. With what we know now, at the present time, it is interesting to recall that Mr. Reid originally favored the smooth type of corn, but was overruled by the other members of the association who were confident that the rough ear was a better and more profitable ear to grow.

In 1902 the Funk Brothers incorporated a seed company. Two of the members of the firm were members of the association and had been producing seed corn for several years. We had been growing a fairly smooth type of corn, but in order to be with the majority, we adopted the rougher type. On the large acreage in our farms we could carry on work with all the varieties listed as standard. It was possible to select strains and carry them along for four or five years with big yields. Then almost invariably and to our surprise those highest yielding strains of rough type corn would go all to pieces and fall down in yield to less than the average farms in the neighborhood. Instead of getting ahead, we were losing out and we could not understand it. Many times we were discouraged almost to the point of giving up the business.

**Seven-Year Test of Seven Corn Types.**

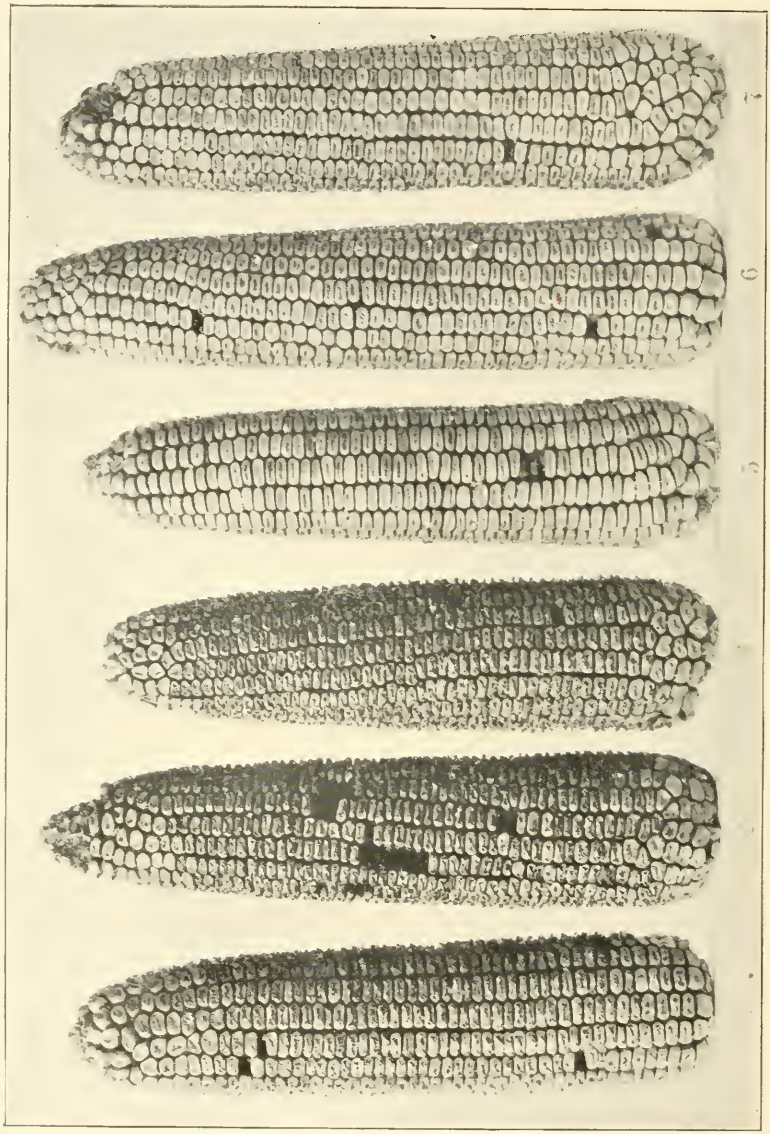
Professor P. G. Holden was with us at the time, and he was such an advocate of the scorecard corn,—the medium rough type,—that I conceived an experiment that would test out the relative value of different types of corn. I started by selecting seven types of corn of the same variety (Leaming) and secured the seed from two different sources. One lot came from E. E. Chester, of Champaign, and the other from J. H. Coolidge, of Galesburg. The seven types ran from the extreme smooth to the extreme rough. These various types were planted in separate rows, usually one-half acre to each type, and I carried on the experiment for seven years. In the corn from the Chester farm the smooth type out-yielded the rough, six times out of seven, and that coming from the Coolidge farm the smooth type was the best five years out of seven.

At the annual meeting of the Illinois Corn Growers at Champaign in 1909, I presented this evidence and showed the samples of corn, and I nearly started a riot. About the only person in the audience who agreed with me was Mr. Reid, who was then seventy years old, and he danced like a schoolboy and said, "I told you so; now I am going home and tend to my own knitting."

This discovery of the superiority of the smooth type, together with the ideas that Mr. Reid had held for so many years, caused us to do a good deal of thinking when we returned home. Some other things happened that caused us to study some more. We were testing our corn for germination. Our germinators were giving us all sorts of trouble, at least we thought it was the fault of the germinator. We spent thousands of dollars trying to get a germinator that would prove satisfactory. All kinds of patented arrangements were used. We tried various materials and home-made gereminators as well as disinfectants. When we put a few kernels from single ears in a square we found that here and there the kernels would mold. Some of these moldy kernels would germinate one hundred per cent. At first we paid no attentoin to the mold, especially when the corn germinated. Later we found that the infection had spread to large areas on the germinator and frequently we threw away a large quantity of corn. For years we were not alive to the source of the trouble, but blamed the germinator.

In 1913 James R. Holbert, who was then a student of Purdue University, came to my farm to spend his summer vacation. He asked if he might have some practical experience, and I sure gave him what he asked for. I first put him in the hay field and on the corn plows, later on an old planter wheel, dragging between the rows to form a dust mulch. We found Mr. Holbert to be above the average student. He wrote his graduation thesis from some of the work that he did with us, and after graduating he asked if he might come back and work for the Seed Company. In the meantime we had come to the conclusion that the root system of the corn plant needed fully as much attention as the stalk or ear. In other words, there was more under the ground that we did not know than there was above ground that we did know. Mr. Holbert was put to studying the root system of the corn plant. This immediately led us to investigate the trouble

we were having with the mold on the germinator. Holbert and I worked on this for three years before we said anything about it. By this time we had discovered that the corn plants throughout the middle west were badly infected by one or more diseases.



Ears of corn (Leaming) grown by E. D. Funk, seven-years test, 1903-1909, showing variation in yield of different type of kernels. In the first test, No. 7 (the smooth type) out-yielded all others six years out of seven; second test, 5 years out of seven.

In the fall of 1916 when Mr. Holbert and his assistant, Mr. Tieman, had finished gathering all the varieties and strains from the breeding blocks they asked me if I could pick from the seven varieties the rows that had given the highest and lowest yields. When I

pointed them out, and did not make a single mistake, they were two surprised boys. I then asked them to open the old cans that contained the type of ears that had stood the seven year test when the smooth type had out-yielded the rough type. We compared types of the crop of 1907 with that of 1916 and found them to be identical.

### Disease Toll National in Extent.

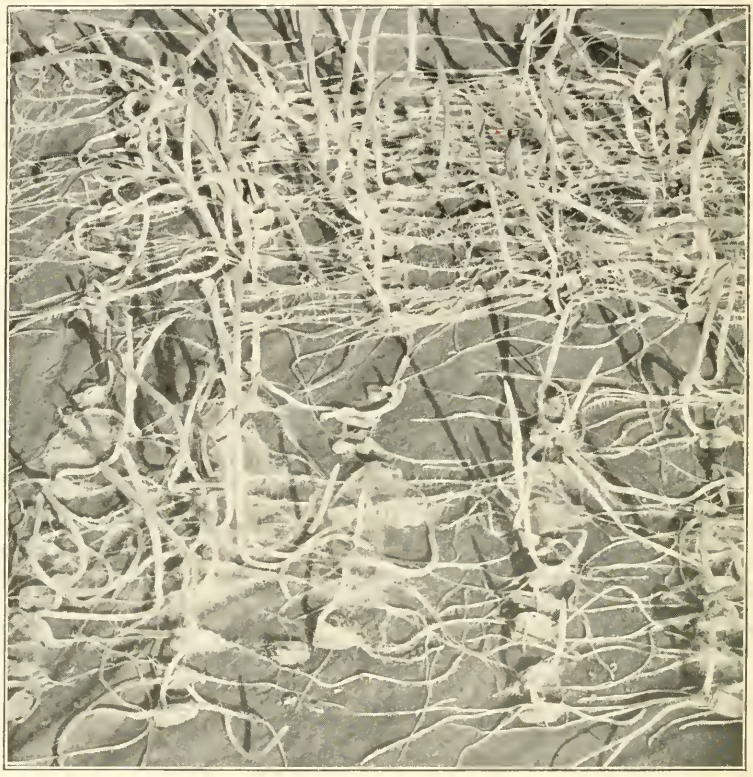
This gave us conclusive evidence that there was some connection between type of corn and the prevalence of the root disease, as well as a correlation between type and yield. It occurred to me that since the corn disease was threatening to be national in character, I decided to take the matter up with the United States Department of Agriculture. I had done some work before in co-operation with the Agricultural Department, with oats, clover and testing of corn stalks for making paper. The government complied with its co-operation, and Mr. Holbert became an employee of the Department and has been working on the problem ever since. A good deal of progress has been made. A lot more investigation remains to be done. It is our hope to discover immune strains within varieties. In the absence of immune strains, we are planting corn that shows free of infection on the germinator and putting this corn in new or clean ground.

The disease clings to old stalks and on various weeds. Contrary to previous teaching we are now burning the stalks to keep the

Reading the results on the Germination Tests.

infection out of the soil. These rots are the same as the wheat scab and are transmissible from corn to wheat, or vice versa. We do not know how long these diseases will remain in the soil, and we are asking the Government and the University of Illinois to make a number of investigations along this line. Also, we should know what

effect certain application of fertilizers on the soil may have toward preventing the disease. We should try to find out if there is any bad effect on livestock fed on infected corn. As you see, there is a lot of work to be done and some of this should be carried out in various parts of the corn belt. The south should be particularly interested, because of the warm, moist climate, the molds will multiply more rapidly and will live through the winter more readily in that territory. I have seen cribs of corn in the south in which more than eighty per cent was infected.



What the Germinator shows—Badly diseased corn in foreground; healthy corn in background.

We do not know how long these diseases have been taking toll of the corn crop, but it seems certain that many farmers do not realize the productive possibilities of their fields. Our corn fields should yield at least twenty per cent more than they are yielding. It is important that the farmer should know the way the disease affects the corn, for it is the connecting link between one crop and the next. Rotting often causes the rear shanks to break, or it discolors them and causes them to show shredded butts when the ear is removed from the stalk. Good looking ears should be under

suspicion if they hang too low or are on broken or rotted shanks. Sometimes a whole ear is soggy or parts of it may have a dry mold. The kernels on diseased ears in many cases are very rough, with shrunken kernels that are dull in color and ears containing starchy kernels should be avoided.

**Select Healthy Seed.**

In a bulletin prepared by Mr. Holbert and Mr. Hoffer they say: "The results of extensive experiments indicate that the best ears are those that ripen on good, normal, upright stalks that remain green while the husk turns yellow to brown and the ears become firm. The best ears usually are not borne perfectly erect, nor do they hang straight down. They are borne on unbroken, unrotted shanks and show no indications of rotting of the kernels. The kernels of such ears are firm with dents, rather shallow and smooth, and have a bright color."

By the use of the germinator we can pick out nearly all of the dangerous ears and have an unusually strong lot of seed. The ordinary four or five days' test is not sufficient. When the temperature is 85 to 88 degrees, seven or eight days will be needed. A lower temperature will require ten to twelve days. Very starchy kernels absorb water more readily and may look better at first than the more horny ones. The strength of the sprouts and its roots will tell part of the story. Kernels from diseased ears will usually develop molds, but even healthy looking ones should be split open with a knife to see if there is any rotting on the inside.

We will now note the pictures: The first one shows the seven types of ears originally selected for the test for which I took seven years to demonstrate and prove a theory. Taking the extreme rough and running to the extreme smooth, we find that the smooth ear in the Chester corn yielded the best six out of seven years, ranging from four to eight bushels during the seven years. The two center ears were the ideal ears selected by the score card, but the smooth ear on the right gave the highest yield.

Now we come to the testing on the germinator. We put the kernels from each ear on the table, starting in each case with the kernel from the butt, taking them from around the ear in a spiral shape, going up to the tip, so that taking the test and reading it from the germination record we can tell whether the butt or the middle or the point of the ear is infected, and to what degree, and in that way keeping a complete record.

The picture shows the germinators, and the men reading the corn, and making the record from each ear.

Now note the pictures showing the germinating corn, first, as they appear on the germinator, and then the individual seedlings. While some are healthy, others are more or less infected, and some are very moldy. Under ordinary conditions that slightly infected would be planted and would grow and make a stalk of corn, but would never produce a good sized ear. We are at that point today, where we have ninety per cent of nubbins. The ears are all less in

Test Plat showing corn from Free-of-Disease Seed on left and from Diseased Seed on the right.

size than they should be, and only ten per cent of good ears of corn in our fields. We should have the reverse, or ninety per cent of good ears and only ten per cent of the nubbins.

### Poor Stands Due to Disease.

Another picture shows the difference in root development, the one on the right being free of disease and the one on the left being slightly affected. We have carefully dug and washed the roots of many corn plants to the depth of six feet in the ground. It takes very careful inspection to eliminate the slightly diseased ears.

The next illustration shows a test plat of free-of-disease seed on the left and diseased seed on the right, planted at the same time. We have often tested our corn and found it ninety-five or ninety-eight per cent of a stand in the field, and then later on we have gone back to the field and counted the stand of corn, and found that the field had dropped down to seventy-eight or eighty per cent in stand. The answer is that this corn gets through the ground, perhaps becomes four or five inches high, and then because of this disease it dies and never gets any farther. I have seen corn wilting and dying, and I would swear that the boys cut the roots off with the plow, when disease is just as likely to be the cause.

A stalk cut through the center is also shown, illustrating the root infection. This is a new root disease. We found this just last summer. I think it is called the "Purple Stalk," but we don't know very much about it. Corn not only has one disease, but we have so far found seven.

Disease in corn generally shows in the foliage losing its color and the leaves beginning to curl. Of course, droughts affect corn, but it affects those plants first which are diseased. They haven't the root system so the moisture can go through the plant, and for that reason they curl up during a dry season.

A still more readily recognized corn disease is what so many saw last summer. Even riding in an automobile at forty miles an hour you could see yellow tassels scattered through the field. This is the result of a disease called "pink stalk barrenness" which usually affects the ear after the stalk has gotten to a mature stage. As a rule the stalk is full size and yet we have the barren ears. We may have a cob with a few kernels on it. The roots may not seem to be so badly infected with the root rot.

### Root Rot Troubles—Avoid Brace Roots.

Now we are getting down to the root rot trouble where the roots are practically all gone and there is nothing left but the brace roots. You will notice a diseased plant will often send out brace roots, nature trying to overcome the lack of a root system in the ordinary condition. That is just contrary to what we used to think. We used to save seed corn from the stalks that had the best brace roots on them. That is one of the most suspicious signs of disease we have today. We very rarely save seed from the stalk that has a number of brace roots. We almost always find later on that seed produced from that plant is infected.

Disease may affect the plant in several different places, largely in the roots, but it may not always infect it so much in the root. There is more than one disease. It may go on to the stalk, then it may wait until it gets to the ear stage, and even up to the ripening of the ear and then attack it.

Q. Is the infection usually in the ground permanently or is it in the seed corn when planted?

Mr. Funk: It is in both. We have found it in the seed corn. We have had years of experience in that line, and we have learned that it remains in the soil at least three years. That is one of the points on which I am asking your co-operation, the University of Illinois and other universities, and the Government, to help us solve some of these problems, to find out how long it remains in the soil, what kind of soil it remains in, and how we can get rid of it. That is what we are asking the experiment people to help us in. Of course, we have to help them in order to get it done.

Free-from-Disease Seedling.

Q. How can we tell if it is in the seed?

Mr. Funk: From the germinator, by germinating corn and testing. If, by looking at an ear and noticing, the ear has a clear shank, if it was broken off from the stalk, whether it broke off clear or whether it had a torn, pithy-like appearance in the cob. You want to avoid anything of that kind. When the ear is of a bright, brilliant luster you can depend upon it being fairly free of disease. If it is of a dark color, looks as though it might have been bleached in the sunlight, or something of that kind, or if it has a rough, starchy kernel, I would avoid an ear of that kind.

Q. Is there any danger of the diseased ear infecting other ears in the same plot?

Mr. Funk: Yes, sir. If both kinds of stalks are in a hill together I would not select an ear for seed at all, no matter how good it seems. Having been in the same hill I would figure it to be almost as much infected as the diseased one.

Q. When one uses one crop of corn after another would the disease be more prevalent?

Mr. Funk: Where you plant crop after crop on the same field you will have more trouble every year. As I said before, you will

find this disease remains on your corn stalks. We have had plants where I knew no corn had been for three years, and we had the disease on these plants.

Avoid brace roots. The inner nodes on plants having a large number of brace roots are invariably dark brown, cutting off circulation. We used to have as good corn as we have today, and I don't know but what we had better, but we did not have the diseases twenty years ago that we have today in so virulent form, and that is the reason why we have to be so careful at this time.

Mr. Holbert: I would like to bear out Mr. Funk in his statement that the extra good ears, the disease-free ears, do not come from such stalks with brace roots. Ordinarily as a rule they come out of the stalks which do not have the roots above the ground. However, that is one of the reasons why I would insist on getting extra well matured ears off of a standing stalk that is maturing normally, with the stalk still green, with the shank sound. If you have that I think the other things will take care of themselves.

### Seed Treatment Not Effective.

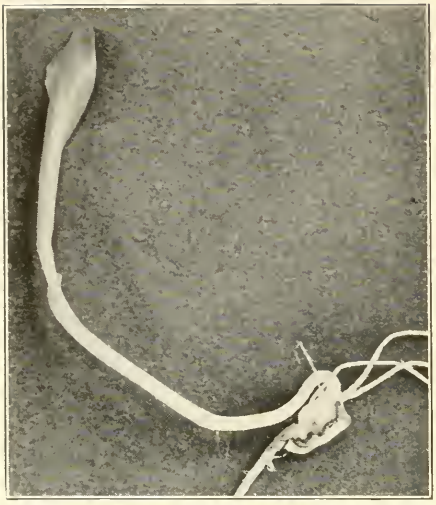
Q. If we can treat oats for smut successfully and potatoes for scab, why can't we treat corn?

Badly Rotted Seedling.

Mr. Funk: Up to the present time every treatment we have been able to give corn and kill the disease has also killed the germ. It is a little different problem from killing smut on oats, as the smut on oats is outside of the shell. Perhaps you can help us solve this problem. We are waiting with open arms to get help on this thing in every way. It is not a one man's job, nor a two-man's job, nor one agricultural university's job; it is a national proposition, and if any man has got an idea let him bring it forward. The door is open to every one. If we won't do this we are going to wake up some of these days and have some drastic laws along these lines. May be some of us will say, "We better not grow corn from the next three years, or five." I hope we will get away from it and not have to resort to anything of that kind.

Q. Do you find that the white corn roots go deeper than the yellow corn?

Mr. Funk: No, I could not say that. We have not tried yellow against white, but I can say that there is very little or no difference, everything else being equal.



Badly Diseased Seedling showing rotted portions on interior of kernel. This type of disease can be detected only by sectioning the seeding at time germination test is read.

Now we come to the comparison of the rough type of corn with the smooth type. I will give you an illustration: A man from one of the counties in this state sent to us twelve hundred ears last fall to make the germination test. He was a man who had in previous years been showing corn at various shows and was considered a good corn grower. We thought his boys must have put something over on him and slipped in twenty ears of smooth variety type of corn among these twelve hundred, for in the whole bunch, the only ears that passed as free of disease were those twenty ears. The rest were a rough type and badly diseased.

That bears out the statement that I have been trying to impress most of all, be careful and avoid the rough or chaffy ears, the ears that have too much starch, and the immature looking ears.

We have found infected ears coming from a corn field that had been planted to corn, then in oats followed by wheat, the three-year-old corn stalks remaining on the ground were turned under. The field was planted the third year to corn that had been tested and then last fall we found wherever the hills would happen to be growing over an old infected corn stalk, and we found more than one of them, we found the stalk or ears affected.

Q. In four years will they come back again?

Mr. Funk: I will answer that next year, and then I will take another year. This investigation will take at least seven years before I can answer that definitely.

Q. Will the disease develop more on fresh land, where you try to grow one crop after the other?

Mr. Funk: No, sir. I would not say that, on perfectly fresh land, unless you should plant badly infected seed, but where you plant corn, three, four and five years, consecutively.

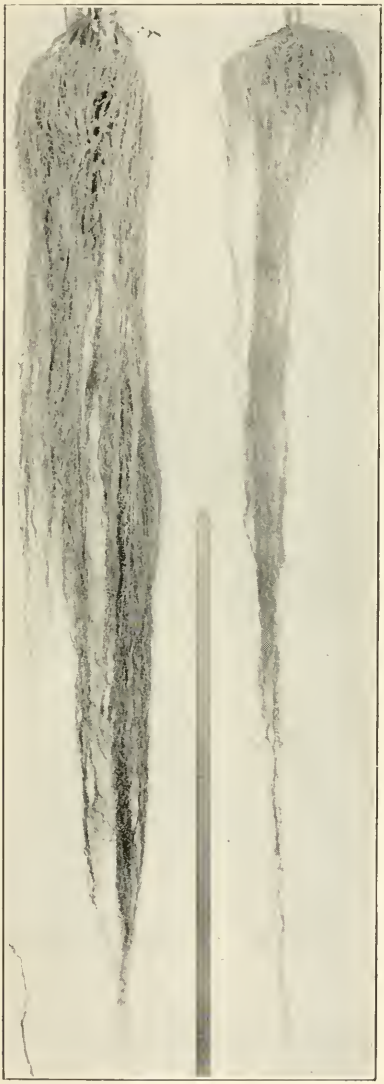
Q. Will the disease be carried through the corn stalk from one year to the other more readily than through the root?

Mr. Funk: I should say both. That is another thing we should determine. I wish I could answer it definitely.

## More Investigation Needed.

Q. Does this disease of the corn, or of the root, in your opinion, have any effect on live stock?

Mr. Funk: That is exactly what I have asked in seeking the aid of the United States Government, the University of Illinois, and any other university, and there is no reason why we could not try it out in Illinois. I have my suspicions that it is a fact. That is not based entirely on theory. I think a lot of this so-called corn stalk disease where we are losing horses and cattle, is due to the very trouble we are studying now, although I can't prove it, it is too big a proposition. Funk brothers have spent a hundred thousand dollars in the investigation of this thing and I am willing to go ahead, but it is quite beyond me, clear beyond me. It is too big a proposition; it is a national proposition, a state and national proposition. I think you will all agree with me that we deserve a little help. You are welcome to come and examine our plant at any time, we will give you all the assistance that we can, because it is a national proposition. We are not trying to keep anything from anybody. If you are a seed man you are welcome; if you are a farmer you are also welcome; even the preacher or lawyer is welcome.



Roots of healthy corn plant on left; roots of badly diseased corn plant on right.

Q. Is it possible for the disease to be distributed by cattle?

Mr. Funk: That is another question I can't answer, sir, although I have in mind a very deep thought along that line. The scientists won't agree with me that that is possible, but I find that the scientists and even myself are wrong sometimes, and I wish that could be worked out.

Q. Could there be anything in the so-called commercial fertilizer that would cause the corn to become diseased?

Mr. Funk: Well, I hardly think so with a fine commercial fertilizer, for the reason that, as a rule, the ingredients that go into a commercial fertilizer must go through a process of heat. In such ingredients as would carry the disease, the heat would kill any germ in the commercial fertilizer.

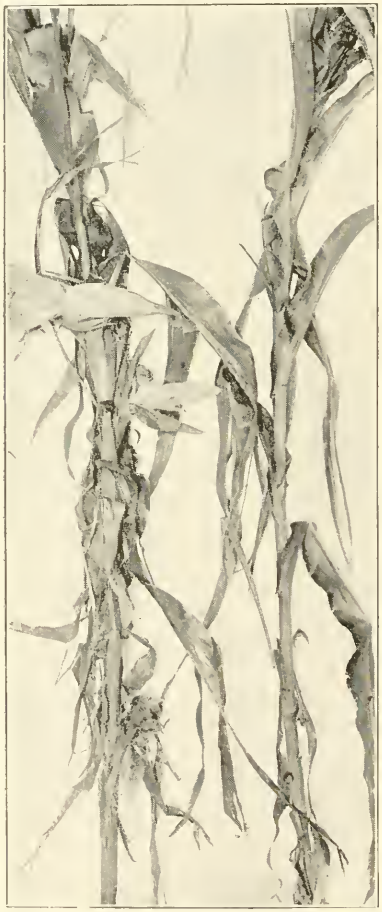
Of course, it would not be carried in raw rock phosphate, that would be out of the question. It would not be carried in limestone. It might be carried in some of the filler, that might be possible, but I don't think that would be hardly probable.

Q. Is there any difference in the chances that diseased corn has in different types of soil?

Mr. Funk: Yes, sir. The plant food naturally in a fertile, rich soil would help, to a certain degree, to overcome the disease, but if you put the seed into poor soil with lack of fertility, naturally that plant could not keep up with its brother in the better soil. I think that would be only a matter of reasoning. I don't think it would require even an experiment to try out that kind of a test.

## Fighting Disease in the Field.

The question is asked whether the disease remained in the soil. We have found hills of corn where it had grown over an old corn stalk, which after three years became badly infected. Here is one of the stalks, the roots and the ears. Here is the root, you see, pulled up. I found this one myself. I was out in the field helping the boys select some seed corn, and I came across this hill of corn. I looked at the ear first, sized up the stalk, and then I pulled the shuck down and I found the ear was moldy. It attracted my attention. I looked at the shuck on the other stalk in the same hill, and I found that it held a nubbin, and I said, "Of course I don't want that ear for seed," but I still looked farther, and down at the bottom, sizing up the plant, I decided to pull it up. It came up so easy it surprised me. I found there was no root system at all. Further investigation showed that there was a piece of the old corn stalk that had been there for three years to my personal knowledge. This field had been planted with free-of-disease seed. After that I found several others of the same kind which is proof that it remains in the soil three years. How much longer we don't know.



Healthy corn plant on left; diseased corn plant on right.

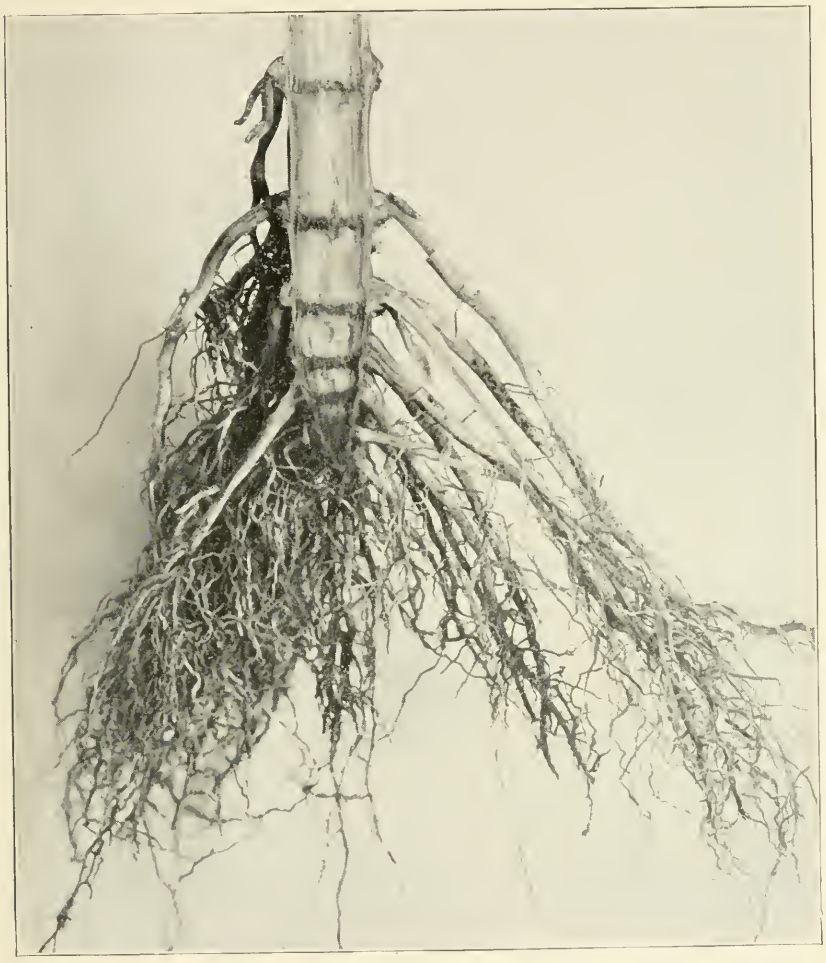
Q. Would you advocate burning the corn stalks?

Mr. Funk: Yes, sir; that is what I would advocate; I would advocate that very thing.

Q. Would it eradicate any of the disease?

Mr. Funk: It would be better than putting the disaese back into the soil.

Q. Will you retain as much fertility by burning the stalks as you will be plowing them under?



Interior of badly diseased corn plant—Note the poor root system and rotted nodes.

Mr. Funk: Yes, sir; you will retain the fertility but you will lose the humus. You can afford to lose some humus in order to get rid of the disease right now.

Q. When you have stalks in your field of corn that have smut on them, what would you do?

Mr. Funk: I would plant that field to something else than corn the next year.

Q. Burn the stalks?

Mr. Funk: Yes, sir. Of course, you understand smut is another proposition, that is another disease from those we have been discussing.

Q. Will you touch on the relationship existing between the root rot in corn and the scab in wheat?

Mr. Funk: We have found that we can transfer the fusarium disease of corn on to wheat, or vice versa. The spore that gets on the wheat from the old corn stalks or weeds, or residue that might be in the field, depends upon the climatic condition at the time of the blooming of the wheat head. It would depend upon the climatic condition, as to whether the infection would occur to any alarming extent. I think it was three years ago that we had the scab so badly. Climatic conditions, moisture and all that sort of thing was ideal for the spores to grow and to light on to the wheat blossom just at the time when it was susceptible to taking on this scab, this disease. Last year, of course, the dry conditions were unfavorable to the propagation of the spores and we had very little wheat scab last year. It all depends on the season.

Q. Is wheat straw dangerous to the corn crop? We have stacks of last year's wheat straw in the field. Our clover stand there was poor, probably we have to break up some of that clover. If we scatter that straw on the ground what effect will that have on corn?

Mr. Funk: I would not be afraid of it at all, because we had very little scab last year. That wheat straw is probably 99 per cent free of the disease.

Q. Would you be alarmed if it was not free from scab?

Mr. Funk: I would be alarmed then, I certainly would sir; I would burn it up.

Q. Do you know whether the disease would exist in manure, and how long it would remain in the manure?

Mr. Funk: That is another question that I am asking the University to help solve. I don't know how long it will remain in the manure. I am hauling about two to three thousand loads of it most every year. I haven't been able to solve it. It will take some years to solve that very question. I wish somebody else would take it up and help to do it.

Q. You made the statement that there was no loss in fertility outside of the loss in organic matter. How would you spread the corn stalk ashes over the field?

Mr. Funk: You could not do it, sir.

Q. Then you are losing some fertility?

Mr. Funk: Losing it in the way of not getting the ashes uniformly scattered over the field, yes, sir; that is true, but I would not say, under the circumstances, I was losing by burning.

Mr. Abbott: Will the roots of diseased corn planted in the soil remain in a diseased condition? If the roots of the corn plants were diseased wouldn't the soil remain in a diseased condition, even though you did burn the corn stalks?

Mr. Funk: If the disease is in the root, naturally, you can't burn the roots very well. If it is in the root it is in the stalk also.

Mr. Abbott: May it not be in the kernel also?

Mr. Funk: Yes.

Q. Is it spread through the soil away from the root? Suppose you destroy the root and the stalk, would that destroy the disease?

Field of corn planted with Free-from-Disease Seed—40 acres averaged 95 bushels per acre—No special soil treatment was used.

Mr. Funk: Of course, if it hasn't anything to live on it dies. If there is something to live on it exists. It has to attach itself on to something.

Q. Is the evidence of the disease on wheat in the head of the wheat?

Mr. Funk: Yes, sir.

Q. Will the disease develop more in unbalaneed soil than it will in balaneed soil?

Mr. Holbert: This year we started investigations at the University by planting diseased seeds on every one of the soil plots that are now in rotation, so in a few years we will be able to answer that question very aeeurately. I might say that the differenee in yield between diseased seed and disease-free seed is greater on poor soil than it is on very fertile soil. However, the addition of limestone, manure and rock phosphate inereases the yield of disease-free seed mueh more. For instance, by the addition of manure, limestone and rock phosphate you can increase the yield of diseased seed from fifty-six bushels up to eighty-three, but if we had used disease-free seed we would have had ninety-seven. Those are the results from the Davenport fields of 1919, and very similar with the three-year result that we had.

### All Corn Fields Infected.

Mr. Funk: There isn't a corn field in the United States that hasn't this disease, from Maine to California. If you have been making a selection along the line of free-of-disease seed I think you are all right.

Q. You say all corn fields are diseased?

Mr. Funk: Every field, sir, has some disease, so far as the government experts tell us. Every field that they have visited they have found this disease more or less. There is one state that has less, perhaps, than others, but it isn't considered a eorn state—Virginia.

Q. What is the particular disease mentioned?

Mr. Funk: There are at least seven of them, sir, some of which have not been named.

Eugene D. Funk and his four sons. From right to left—Eugene D., Sr.; Lafayette, Jr.; Paul: Theodore; Eugene, D., Jr.

## Score Card for Utility Corn.

(Adopted by the Illinois Corn Growers' Association.)

| | Perfect Score |
|---|---|
| General Appearance— | |
| Indentation | 5 |
| Kernel Composition | 5 |
| Kernel Characteristics | 10 |
| Shank Attachments | 10 |
| Tip of Ears | 5 |
| Luster or Polish | 10 |
| Type and Uniformity— | |
| Type | 5 |
| Length | 5 |
| Color | 5 |
| General Uniformity | 5 |
| Germination Record— | |
| Vitality and Vigor | 20 |
| Freedom from Disease Symptoms | 15 |
| Total | 100 |

General Appearance ..... 45

Indentation ..... 5

Ears with distinctly rough chaffy indentation are ferquently imperfectly matured owing to the presence of disease. Very rough indentation is objectionable and will be discriminated against.

Kernel Composition ..... 5

Starchy seed ears produce many diseased plants which give unsatisfactory yields.

Kernel Characteristics ..... 10

Kernels from normally matured healthy ears are nearly always thick, plump, bright and clean, and possess well developed germs. Such kernels usually have distinctly horny endosperm.

Shank Attachments ..... 10

Many ears which have pink, slightly pink, brown, or shredded shank attachments were produced on diseased stalks. Frequently such ears may have an otherwise good appearance but whenever any of the above symptoms are found the ear should be discarded. (Note: All ears must have the shank attachments intact just as the ear was broken from the stalk. Any effort to trim out or alter the shank appearance will eliminate the sample from competition.)

Tips of Ears ..... 5

The tips of the ears should be bright and free from "weathering" or discoloration of any kind.

Luster or Polish ..... 10

Ears having a bright, rather oily appearance have proven themselves superior as seed ears. This appearance indicates a normal, healthy development and complete maturity and is associated with greater vigor. Such ears possess higher yielding qualities than ears which are rather dull, dead or dry looking and which have no luster.

Type and Uniformity ..... 20

Type ..... 5

Kernels from the different ears should be uniform in size and shape.

Length ..... 5

The sample should conform to the accepted standards of length as approved by the State Corn and Grain Growers' Associations.

Color ..... 5

The shade of color of the different ears in the sample and from different portions of the same ear should be uniform.

General Uniformity ..... 5

All ears in the sample should be uniform in shape.

Germination Record ..... 35

Vitality and Vigor ..... 20

The seedlings in the germination test should show thick, sturdy sprouts, and good root development. Tall, slender, weak seedlings and those having short slender feeder roots are not desirable.

Freedom from Disease Symptoms ..... 15

A moldy discolored condition of the kernels near the point of attachment to the cob indicates disease.

## SOME INSTITUTE PUBLICATIONS

Annual Report, 1895-1921. (Handbook of Agriculture.)
Annual Bulletin, 1904-1921.
Illinois Farmers' Institute—Organization, Object and Activities.
Illinois—Mighty Agricultural Patriot.
Lectures on Poultry Husbandry. (Circular No. 3.)
Important Insects of Truck Gardens. (Circular No. 4.)
Suggestions for Corn Contests. (Circular No. 5.)
Principles and Practices of Land Drainage. (Circular No. 7.)
Ways to Win With Wheat.
A Liberty Garden for Every Home.
Poultry Helps in War Time.
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Limestone and Phosphate.
Phosphate Storage Bins.
Corn Disease Investigations.
Modern Agriculture in Southern Illinois.
Score Cards for: — Corn, Potatoes, and Oats.

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